

NEC-2370-US
Amendment dated 01/23/2004

09/853,622

04150012aa
Reply to office action mailed 10/23/2003

The following is a complete listing of all claims in the application, with an indication of the status of each:

Listing of claims:

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1. (currently amended) A magnetoresistive effect sensor using a shielded-type magnetoresistive effect element comprising:
a magnetoresistive effect film above a lower shield layer, said film comprising a basic configuration that is a combination of a free layer, a barrier layer, and a fixed layer, wherein either a combination of a free layer, a said barrier layer is formed on said free layer, and a said fixed layer is formed on said barrier layer, or a combination of a fixed layer, a said barrier layer is formed on said fixed layer, and a said free layer is formed on said barrier layer, said barrier layer inheriting a roughness of said lower shield layer, wherein a sensing current flows substantially perpendicularly with respect to said magnetoresistive effect film, and wherein either an amorphous material or a microcrystalline material is used in a said lower shield layer so as to smooth said lower shield layer, thereby increasing the smoothness of said barrier layer.

2. (original) A magnetoresistive effect sensor according to claim 1, wherein said lower shield comprises a crystal grain diameter of 6.2 nm or smaller.

3. (currently amended) A magnetoresistive effect sensor according to claim 1 or claim 2, wherein said lower shield is made of a material of CoZrTa, with a and CoZrTaCr alloy serving as a base layer for said free layer.

4. (withdrawn) A magnetoresistive effect sensor according to claim 1, wherein said lower shield is formed by means of sputtering.

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1 5. (withdrawn) A magnetoresistive effect sensor according to claim 1,
2 wherein a magnetoresistive effect film having a basic configuration that is
3 either a combination of a free layer, a barrier layer formed on said free layer,
4 and a fixed layer formed on said barrier layer, or a combination of a fixed
5 layer, a barrier layer formed on said fixed layer, and a free layer formed on
6 said barrier layer is formed on said lower shield directly or formed thereon via
7 an intervening base layer.

1 6. (withdrawn) A magnetoresistive effect sensor according to claim 1,
2 wherein a lower conductor layer is disposed at a bottom part of a
3 magnetoresistive effect film having a basic configuration that is either a
4 combination of a free layer, a barrier layer formed on said free layer, and a
5 fixed layer formed on said barrier layer, or a combination of a fixed layer, a
6 barrier layer formed on said fixed layer, and a free layer formed on said barrier
7 layer, a bottom part of said lower conductor layer being in contact with a
8 lower shield.

1 7. (withdrawn) A magnetoresistive effect sensor wherein in a
2 magnetoresistive effect element in which a conductor layer is disposed at a
3 bottom part of a magnetoresistive effect film having a basic configuration that
4 is either a combination of a free layer, a barrier layer formed on said free layer,
5 and a fixed layer formed on said barrier layer, or a combination of a fixed
6 layer, a barrier layer formed on said fixed layer, and a free layer formed on
7 said barrier layer, in contact either with an intervening base layer or directly
8 therewith, wherein said lower conductor layer functions as a lower electrode to
9 cause a sensing current to flow in said magnetoresistive effect film, and

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10 further wherein a lower conductor is made of a material selecting from a group
consisting of an amorphous material and a microcrystal.

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8. (withdrawn) A magnetoresistive effect sensor according to claim 7,
wherein said microcrystal forming said lower conductor layer comprises a
crystal grain diameter of 5.4 nm or smaller.

9. (withdrawn) A magnetoresistive effect sensor according to claim 7,
wherein said lower conductor layer is formed by sputtering.

10. (withdrawn) A magnetoresistive effect sensor according to claim 1,
further comprising a layer which fixes a magnetization of a fixed layer,
provided so as to be in contact with said fixed layer.

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11. (withdrawn) A method for manufacturing a magnetoresistive effect
sensor whereby a shielded-type magnetoresistive effect element in which a
sensing current flows substantially perpendicular to a magnetoresistive effect
film, using a magnetoresistive effect film having a basic configuration that is
either a combination of a free layer, a barrier layer formed on said free layer,
and a fixed layer formed on said barrier layer, or a combination of a fixed
layer, a barrier layer formed on said fixed layer, and a free layer formed on
said barrier layer, wherein a material selected from a group consisting of an
amorphous material and a microcrystalline material is used in a lower shield.

12. (withdrawn) A method for manufacturing a magnetoresistive effect
sensor according to claim 11, wherein said microcrystal used in said lower
shield comprises a crystal grain diameter of 6.2 nm or smaller.

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1 13. (withdrawn) A method for manufacturing a magnetoresistive effect
2 sensor according to claim 11, wherein said lower shield is formed using
3 sputtering.

1 14. (withdrawn) A method for manufacturing a magnetoresistive effect
2 sensor according to claim 11, wherein a magnetoresistive effect film having a
3 basic configuration that is either a combination of a free layer, a barrier layer
4 formed on said free layer, and a fixed layer, or a combination of a fixed layer,
5 a barrier layer formed on said fixed layer, and a free layer is formed on said
6 lower shield directly or formed thereon via an intervening base layer.

1 15. (withdrawn) A method for manufacturing a magnetoresistive effect
2 sensor according to claim 11, whereby a lower shield layer is formed and a
3 lower conductor layer is formed on said lower shield layer, and further
4 whereby a magnetoresistive effect film having a basic configuration that is
5 either a combination of a free layer, a barrier layer formed on said free layer,
6 and a fixed layer, or a combination of a fixed layer, a barrier layer formed on
7 said fixed layer, and a free layer formed on said barrier layer is formed on said
8 lower conductor layer, either directly or via an intervening base layer.

1 16. (withdrawn) A method for manufacturing a magnetoresistive effect
2 sensor whereby a magnetoresistive effect film having a basic configuration
3 that is either a combination of a free layer, a barrier layer formed on said free
4 layer, and a fixed layer, or a combination of a fixed layer, a barrier layer
5 formed on said fixed layer, and a free layer formed on said barrier layer is
6 formed either directly on a lower conductor layer or thereonto with an
7 intervening base layer, and further wherein, said lower conductor layer being

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8 made of a material selected from a group consisting of an amorphous material
9 and a microcrystalline material.

17. (withdrawn) A method for manufacturing a magnetoresistive effect
sensor according to claim 16, whereby said lower conductor layer is formed by
a microcrystal comprising a crystal grain diameter of 5.4 nm or smaller.

18. (withdrawn) A method for manufacturing a magnetoresistive effect
sensor according to claim 16, whereby said lower conductor layer is formed by
sputtering.

19. (withdrawn) A method for manufacturing a magnetoresistive effect film
according to claim 11, whereby a layer fixing a magnetization of a fixed layer
is further formed, so as to be in contact with said fixed layer.

20. (withdrawn) A magnetoresistance detection system comprising a
magnetoresistive effect sensor according to claim 1, a means for generating a
current passing through a magnetoresistive effect sensor, and means for
detecting a change in magnetoresistance of said magnetoresistive effect sensor
as a function of a detected magnetic field.

21. (withdrawn) A magnetic recording system comprising a magnetic storage
medium comprising a plurality of tracks for data recording, a magnetic
recording system for storing data on said magnetic storage medium, a
magnetoresistance detection system according to claim 20, and an actuating
means lined to said magnetic recording system and a magnetoresistance
conversion system for the purpose of causing said magnetic recording system

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8 and said magnetoresistance detection system to move to a selected track of
said magnetic storage medium.
